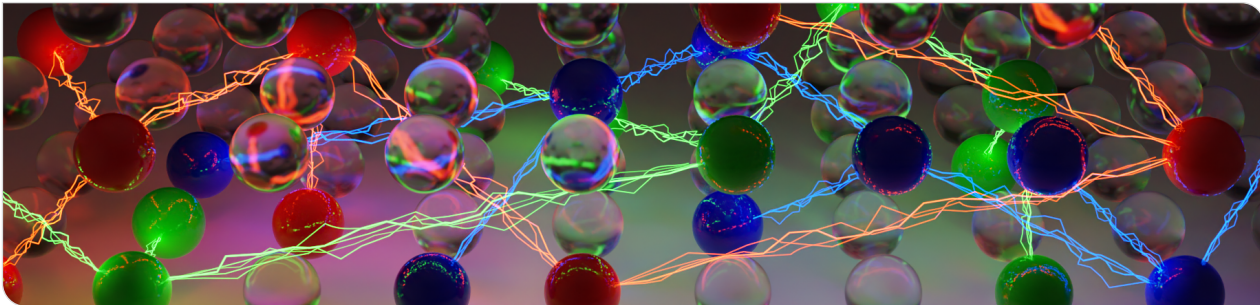# Fortgeschrittene Themen im SAT Solving

Seminar Kick-Off

Ashlin Iser, Dominik Schreiber, Niccolò Rigi-Luperti | 6. November 2025

Organisatorisches

- Ausführlicher Vortrag (30 min. + 15 min. Fragen), keine Ausarbeitung
- 2-3 Papiere aus einem gemeinsamen Themenblock einordnen, kommentieren, vergleichen
- Unterstützung und Beratung von Betreuerseite
- *n* Vortragstermine (für kleine *n*) nach Absprache

iser@kit.edu

niccolo.rigi-luperti@kit.edu

dominik.schreiber@kit.edu

Topics: The Big Picture

- Which innovative paradigms for SAT solving and its extensions have emerged in the past few years?
- How can we exploit modern hardware for dependable SAT solving and its applications?
- How can we understand and exploit statistical properties of solvers and problems?

SAT and its Extensions

1. CDCL and Local Search

2021, Cai et al., "Deep Cooperation of CDCL and local search for SAT"
2022, Cai et al., "Better decision heuristics in CDCL through local search and target phases"

2. Variable Addition

2012, Manthey et al.: Automated Reencoding of Boolean Formulas
2023, Haberlandt et al.: Effective Auxiliary Variables via Structured Reencoding

3. MaxSAT

2016, Saikko et al., "LMHS: A SAT-IP Hybrid MaxSAT Solver"
2023, Ihalainen et al., "Unifying Core-Guided and Implicit Hitting Set Based Optimization"
2025, Ihalainen et al., "Unifying SAT-Based Approaches to Maximum Satisfiability Solving"

4. Pseudo-Boolean Reasoning: Propagation beyond Clauses

2024, Nieuwenhuis et al., "Speeding-up Pseudo-Boolean Propagation"
2025, Müßig & Johannsen, "Improving Watched Pseudo-Boolean Propagation with Significant Literals"

Dependable Solving and Modern Hardware

5. Proofs in Parallel & Distributed SAT

2016, Heule et al., "Solving and verifying the boolean pythagorean triples problem via cube-and-conquer"
2023, Michaelson et al., "Unsatisfiability Proofs for Distributed Solvers"
2024, Schreiber, "Trusted Scalable SAT Solving with on-the-fly LRAT Checking"

6. GPU-accelerated SAT Solving

2019, Osama and Wijs, "Parallel SAT Simplification on GPU Architectures"
2021, Prevot et al., "Leveraging GPUs for Effective Clause Sharing in Parallel SAT Solving"
2024, Osama et al., "SAT Solving with GPU Accelerated Inprocessing"
2025, Cen et al., "Massively parallel continuous local search for hybrid SAT solving on GPUs"

7. Parallel Model Counting

Burchard et al. (2015): Laissez-Faire Caching for Parallel #SAT Solving
Lagniez et al. (2018): DMC: A Distributed Model Counter

Data Science and Applications

8. Algorithm Selection for NP Problems

2008, Xu et al., "SATzilla: Portfolio-based Algorithm Selection for SAT"
2022, Heins et al., "A study on the effects of normalized TSP features for automated algorithm selection"

9. Circuit Equivalence Checking

Bacchus et al. (2002): Enhancing Davis Putnam with Extended Binary Clause Reasoning
Biere et al. (2024): Clausal Congruence Closure

10. Future Application: Quantum Circuit Layout

2024, Shaik et al., "Optimal Layout Synthesis for Deep Quantum Circuits on NISQ Processors with 100+ Qubits"
2024, Yang et al., "Quantum Circuit Mapping Based on Incremental and Parallel SAT Solving"

11. Formally Explainable AI (FXAI)

2024, Paul et al., "Formal Explanations for Neuro-Symbolic AI"
2024, Marques-Silva, "Logic-Based Explainability: Past, Present & Future"